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Human Systems Integration (HSI) Tradeoff Model

Anthony P. Tvaryanas, M.D, Ph.D, M.P.H.&T.M.

Andrea Cooks, Horace Orr, Lisa Kaminski

SURVIAC
46 TG/OL-AC/SURVIAC
2700 D Street
Wright Patterson AFB OH 45433-7404

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Technical Report

AIR FORCE RESEARCH LABORATORY
711TH HUMAN PERFORMANCE WING
HUMAN SYSTEMS INTEGRATION DIRECTORATE
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-7320
AIR FORCE MATERIEL COMMAND

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ANTHONY P. TVARYANAS, Colonel, USAF	MATTHEW T. TARANTO, Major, USAF
Technical Director	Chief, Human Systems Analysis Division
Human Systems Integration Directorate	Human Systems Integration Directorate
711th Human Performance Wing	711th Human Performance Wing
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14. ABSTRACT
At the direction of 711 HPW/HP, SURVIAC developed the HSI Tradeoff Demonstration Model to build awareness of Human Systems Integration (HSI) and HSI-related engineering concepts. The model, built in the form of a software tutorial, also improves the ability of program management professionals to identify potential HSI tradeoffs in program management and systems engineering functional areas, and demonstrates how these HSI-related tradeoffs influence system level tradeoffs. This report provides a top-level overview of the model, a step-by-step explanation of the mathematical basis for two HSI tradeoff exercises contained in the model, and summaries of two usability tests performed on the model.

15. SUBJECT TERMS
Human Systems Integration, HSI, Manpower, Personnel, Training, Human Factors, Survivability, Habitability, Environment, Safety, Occupational Health, SURVIAC collection

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1.0 Introduction

The United States Air Force (USAF) is in the process of institutionalizing Human Systems Integration (HSI) as an embedded process, to ensure human considerations and performance capabilities and limitations are addressed in the life cycle management of USAF weapons systems. Interim Department of Defense Instruction (DoDI) 5000.02, *Operation of the Defense Acquisition System*, states, "The Program Manager will plan for and implement human systems integration (HSI) beginning early in the acquisition process and throughout the product life cycle. The goal will be to optimize total system performance and total ownership costs, while ensuring that the system is designed, operated, and maintained to effectively provide the user with the ability to complete their mission."

Regardless of the sophistication of AF systems, optimized total system performance is contingent upon the warfighter's ability to use systems fully and effectively to accomplish the mission. HSI provides an integrated approach to considering the human on par with the hardware and software they are expected to operate, maintain, and support. Effective management of HSI design considerations and tradeoffs within overall system engineering and program management is essential to achieving the required system performance while making economical demands upon personnel resources, minimizing life cycle costs, and managing the risk of loss or injury to personnel, equipment, or the environment.

Identifying optimal HSI solutions within the life cycle management process is a complex endeavor requiring a holistic understanding of the relationships between the nine distinct conceptual HSI "domains" (i.e., Manpower, Personnel, Training, Human Factors Engineering, Survivability, Habitability, Safety, Environment, and Occupational Health) and the ability to manage interactions between these domains.

The 711th Human Performance Wing Human Systems Integration Directorate (711 HPW/HP) is working to address a perceived capability gap within AF program management and acquisitions arenas, by: 1) emphasizing the importance of including HSI considerations in the system design and development process; and 2) enhancing the understanding of HSI tradeoffs.

At the direction of 711 HPW/HP, the Survivability/ Vulnerability Information Analysis Center (SURVIAC) developed the HSI Tradeoff Demonstration Model to build awareness of HSI and HSI-related engineering concepts. The model, built in the form of a software tutorial, also develops the ability of program management professionals to more easily identify potential HSI tradeoffs in program management and systems engineering functional areas, and demonstrates how these HSI-related tradeoffs influence system level tradeoffs.

Section 2.0 of this report provides a top-level overview of the model. Section 3.0 contains a step-by-step explanation of the mathematical basis for two HSI tradeoff exercises contained in the model. Summaries of two usability tests performed on the model are presented in Section 4.0.

2.0 Overview of the HSI Tradeoff Demonstration Model

The HSI Tradeoff Demonstration Model (hereinafter designated as "the model") is an HTML application that enables program managers and engineers to familiarize themselves with HSI in an interactive fashion, first by reading a top-level introduction to HSI and the constituent domains, and then by stepping through a series of HSI-related tradeoffs on two notional development programs.

Upon opening the application,[1] the user is presented with the home screen shown in Figure 1. The screen has three "clickable" buttons:

- What is HSI?
- TSA Scenario; and
- UAS Scenario

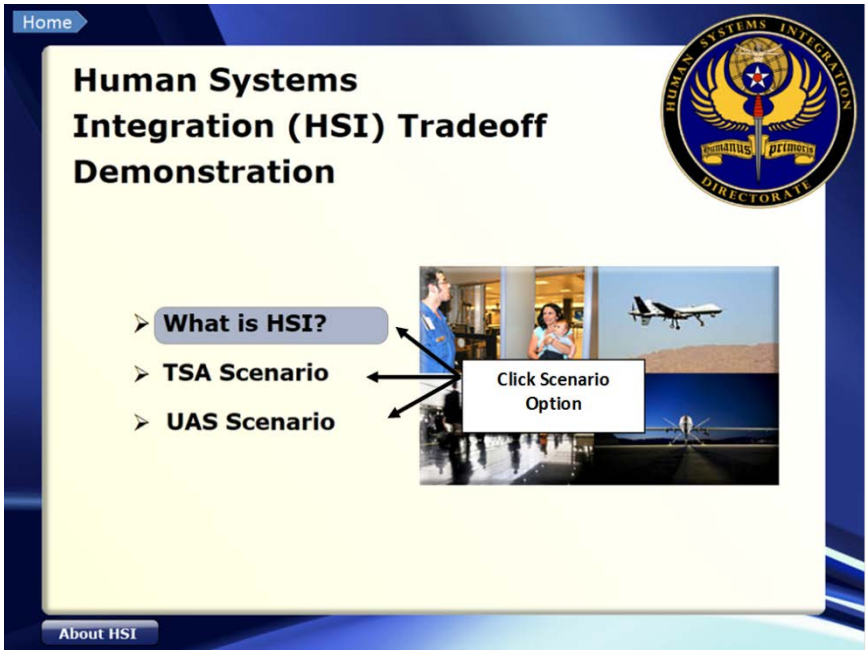


Figure 1 Home Screen

2.1 What is HSI?

The 'What is HSI?' section gives an introduction to HSI and its constituent domains and helps the user understand that there are tradeoffs between each domain. Background information, definitions, and examples can be found here.

2.2 Transportation Security Adminstration (TSA) Scenario

This section is a mock scenario to improve airport passenger screening through the purchase of a surveillance system. Two systems are available: "Touchless Invader" and "Spinex." Users must also select appropriate amounts of manpower, personnel aptitude, and training. The goal is to find a solution that: (1) remains within budget; and (2) meets minimum requirements for passenger throughput and detection rate. Users are presented with the corresponding results of their choices and informed whether or not they have passed/failed or found the optimal solution.

2.3 Unmanned Aircraft System (UAS) Scenario

This section is based on the use of UAS by local law enforcement. Users must choose a configuration for control station monitors that will optimize UAS operator workload and remain within a budget. As in the TSA scenario, they are then presented with the corresponding results of their choices, and informed whether or not they have passed/failed or found the optimal solution.

[1] Requirements for installation of the model and opening instructions are found in Appendix C.

2.4 Navigation

To navigate within the application, the user clicks on arrows at the bottom of the screen to go to the next or previous screen. To go to the home screen and start over, he/she clicks the 'Home' button in either the bottom left or top left corners. There is also a "breadcrumb trail" at the top that will indicate where the user currently is within the application. Clicking on any previous section will take the user back to that section of the scenario (See Figure 2).

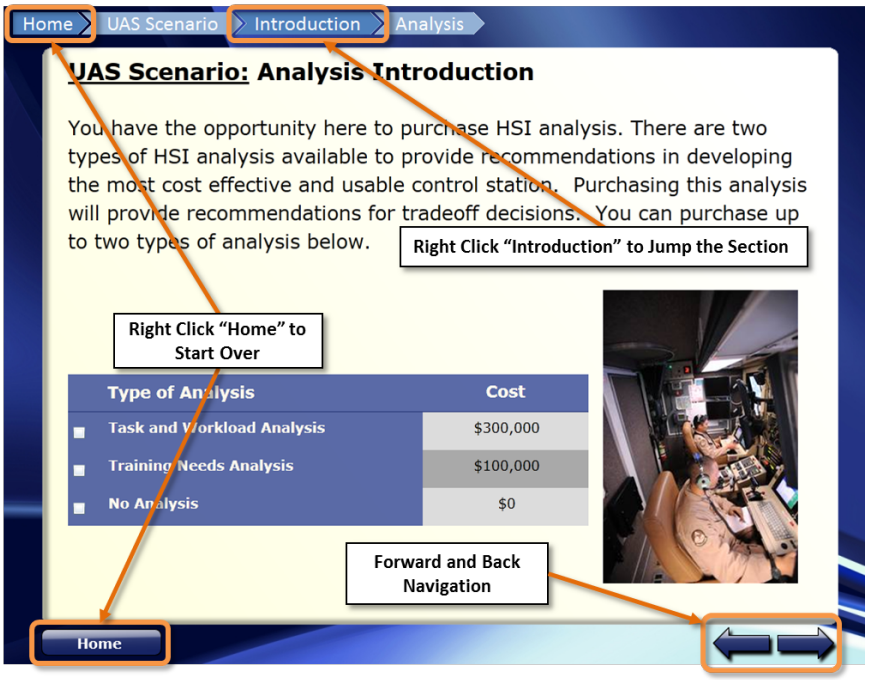


Figure 2 Navigation

2.5 User Input

Throughout the application, the user is prompted to provide input. Checkboxes allow for multiple selections using the mouse (Figure 3). Radio buttons, on the other hand, only allow the user one selection, also selected using the mouse (Figure 4). Finally, the drag and drop interface enables the user to select a component by left-clicking and holding, dragging the mouse to the desired destination, and then releasing the button (Figure 5).

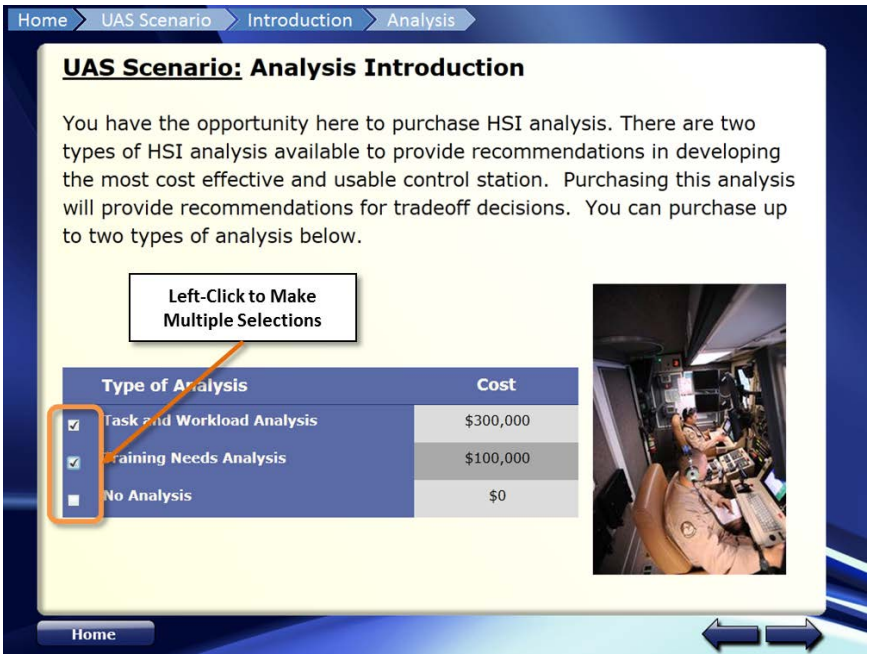


Figure 3 Check Boxes

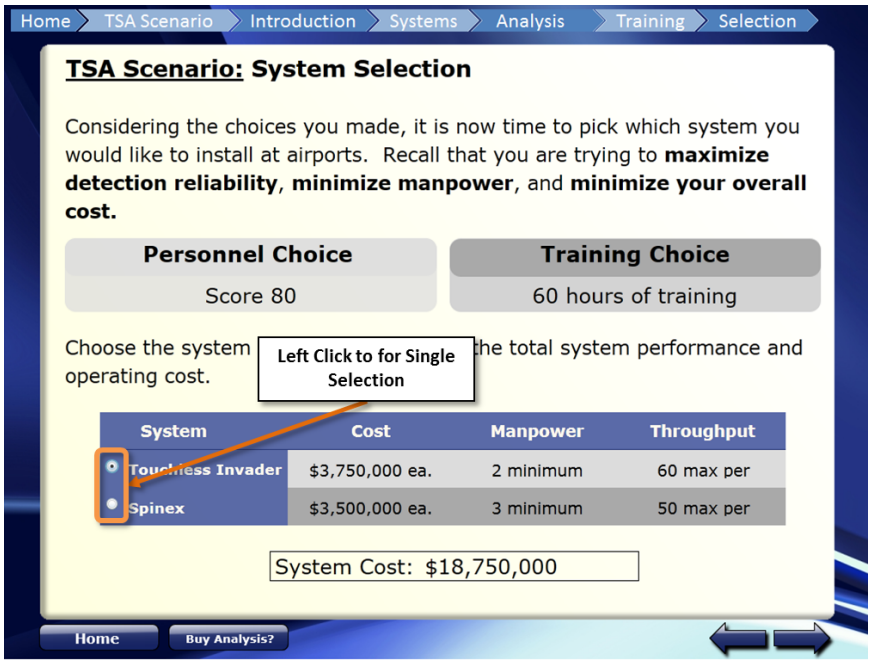


Figure 4 Radio Buttons

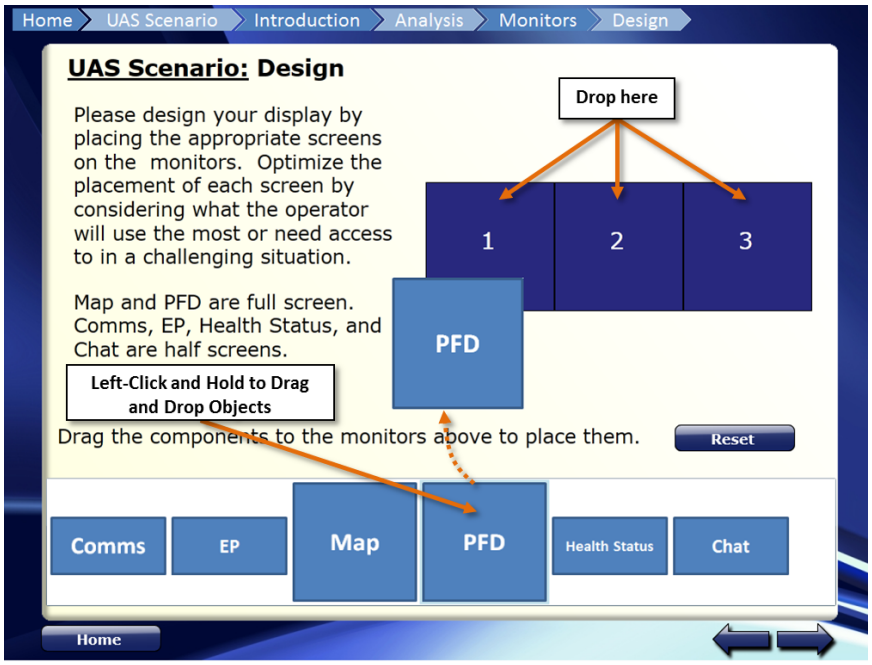


Figure 5 Drag and Drop

2.6 Optimal Solutions

Each scenario has an optimal solution that the user attempts to achieve. These solutions are driven by different factors depending on the scenario.

2.6.1 TSA Scenario Solution

In this scenario, there are three conditions that must be met in order for the user to be successful. First, he/she must procure and operate a system within a budget of $20 million. This means choosing

personnel skill levels, training, HSI analyses, and a system that all fall within this budget. Second, a throughput of at least 250 passengers per hour must be achieved. Finally, the system must have at least a 97% detection rate to be a viable solution.

An optimal solution is one that combines lowest cost with most efficient operation and training time. In this scenario, the optimal solution is as follows (does not take into account purchase of available HSI analyses):

- Aptitude: Score of 60
- Training: 60 hours
- System: Touchless Invader

2.6.2 UAS Scenario Solution

The UAS scenario has two conditions that must be met in order to have a successful system. The first is to procure a system within a budget of $3 million. The second condition is to minimize the operator's visual workload. Once these conditions are met, the user will have a successful solution.

An optimal solution stays within budget and has the lowest visual workload. In this scenario, there is a best solution for each screen configuration. Figure 6 shows the best solution for each configuration. Configuration C is the overall optimal solution for all screen configurations.

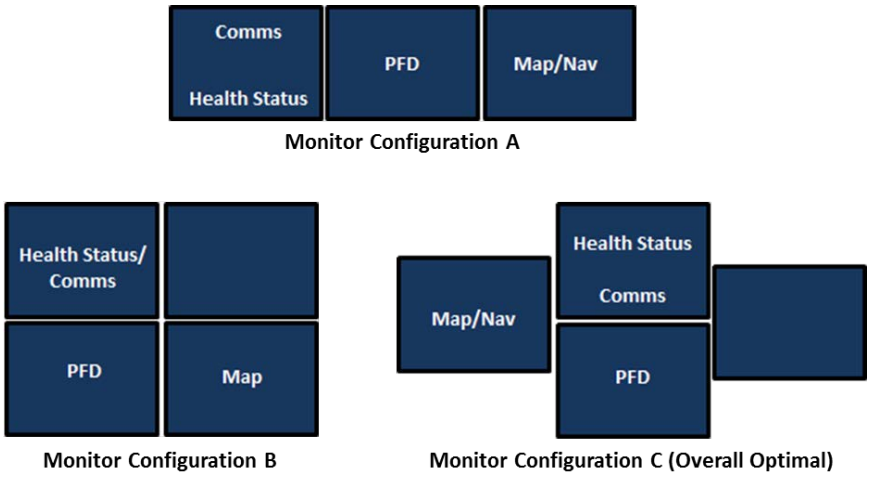


Figure 6 Optimizing the Monitor Configuration

3.0 Scenarios and Tradeoff Model Details

This section describes the two scenarios in detail, and provides the mathematical models that are used to score them.

3.1 TSA Scenario

The aim of the TSA scenario is to improve airport passenger screening through the purchase of a surveillance system. The user may perform or purchase HSI analysis to choose a system that meets performance goals. The three goals identified for this scenario are:

- Stay within a budget of $20M
- Maintain throughput of 250 passengers/hour
- Meet required reliability of 97%

Major HSI domains and activities assessed in this scenario include choices of: (1) ***initial personnel skill level***; (2) ***training***; and (3) ***amount of manpower*** employed. Manpower requirements are determined by the user's choice of surveillance system (i.e., ***Touchless Invader*** or ***Spinex***). Throughput capability varies as a function of personnel skill levels, which are derived from incoming skill level (***aptitude scores***) and ***additional training required***. ***Aptitude scores*** and ***additional training*** are variables chosen by the user when establishing the parameters of the scenario.

This scenario shows the importance of assessing HSI domains in conjunction with other risks and decision-making activities. HSI is intrinsically integrated with cost and performance. To design a system correctly, additional studies, analyses, and design considerations may be necessary.

Since this is a hypothetical trade-off analysis, SURVIAC first created a dataset for total system cost (TC_S):

$$TC_S = nC_S + (C_T + S_P)N_O$$

where n is the number of systems, C_S is the cost of the system, C_T is the cost of training each operator, S_P is the burdened salary for each operator (for the specified period) and N_O is the number of operators required.

System cost (C_S) is assumed to be a given value based on the ***retail cost*** established by the manufacturer (based on scenario) and the ***manpower cost*** to operate the system. ***Training Cost*** (C_T) is a linear function of cost per hour, with x representing number of hours and C_h representing minimum cost per hour ($200).

$$C_T = xC_h$$

$$C_T = 200x$$

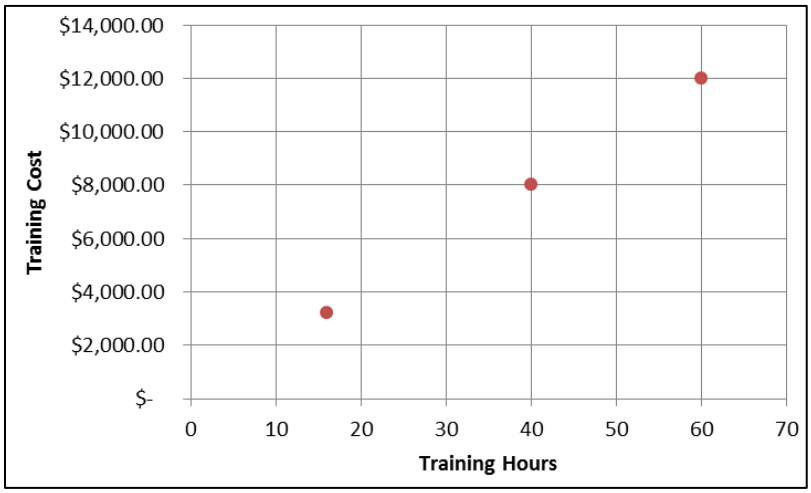


Figure 7 Training Cost as a Function of Training Hours

Personnel Salary (S_P) is a function of the individual's initial skill level as reflected by their aptitude score (x_a). Salary increases in direct proportion to higher aptitude scores.

$$S_P = 2000x_a - 50{,}000$$

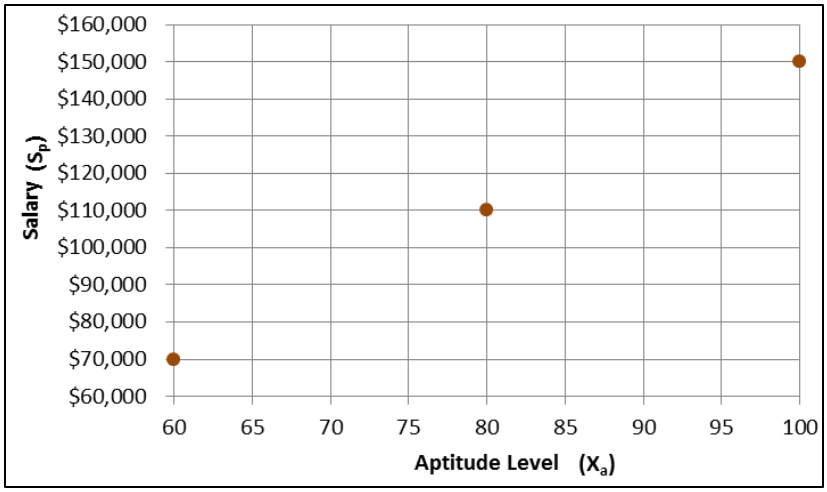


Figure 8 Personnel Salary versus Aptitude Score

The user must then make a system choice between two systems (shown below in Table 1).

Table 1 TSA System Choices

System	Cost ($M)	Minimum Manpower	Throughput (People per hr.)
Touchless Invader	3.5	2	60
Spinex	3.0	3	50

SURVIAC integrated a Training Needs Analysis and a Throughput and Manpower Analysis into the TSA scenario to assist with decision making, if the user chooses. Because of the importance in presenting tradeoffs, these analyses are only made available for an additional cost. These analyses emphasize the message that additional upfront investment, through studies, analysis, or other design considerations, is often needed to design a system correctly.

The Training Needs Analysis provides the user with information on the inverse relationship between initial personnel skill levels and the amount of subsequent training needed to meet the required 97% detection rate (See Figure 9).

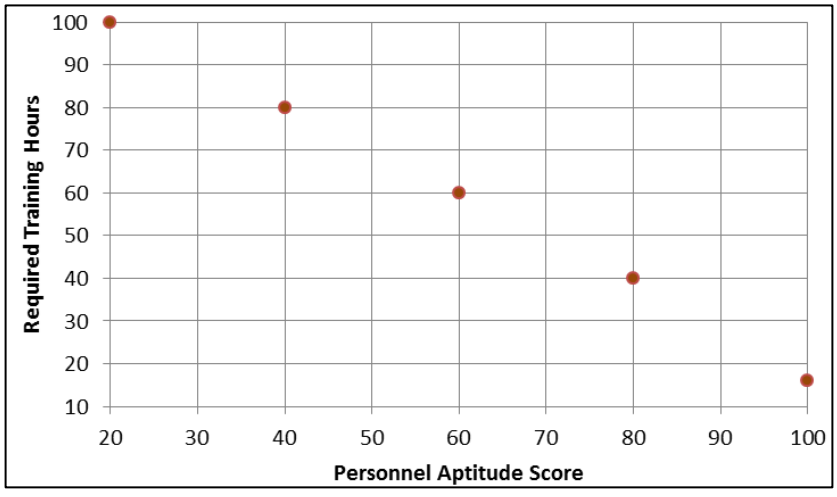


Figure 9 Training Hours versus Aptitude Score for 97% Detection Level

Throughput and Manpower Analysis provides analysis on the number of people who can be screened per hour while still meeting the required detection rate. Combining this information with the Training Needs Analysis provides the user with a required number of systems and manning levels to meet the throughput goal.

System A (Touchless Invader)					System B (Spinex)				
Training Hrs	Personnel Aptitude	Throughput	Reliability (%)	Initial Cost (1yr)	Training Hrs	Personnel Aptitude	Throughput	Reliability (%)	Initial Cost (1yr)
16	100	60	97	$ 21,532,000	16	100	50	98	$19,798,000
40	100	60	97	$ 21,580,000	40	100	50	98	$19,870,000
40	80	60	97	$ 21,180,000	40	80	50	98	$19,270,000
60	100	60	97	$ 21,620,000	60	100	50	98	$19,930,000
60	80	60	97	$ 21,220,000	60	80	50	98	$19,330,000
60	60	60	97	$ 20,820,000	60	60	50	98	$18,730,000

Figure 10 Acceptable Solutions and Costs

Appendix D contains all data and information used in the creation of this model. This information is notional and only valid within the context of this scenario and model.

3.2 UAS Scenario

The UAS scenario demonstrates the importance of HSI through the design of a display system for operating unmanned aircraft in a law enforcement capacity, such as border patrol, suspect tracking, or location monitoring. In this scenario, there is an increased potential for system loss due to operator error.

This scenario focuses on three objectives:

- Procure a system within a budget of $3M
- Improve the design of the system
- Minimize operator's visual workload

The user must design a new operator workstation, choosing the physical configuration of the display monitors, location of output data displayed, operator skill level, and amount of training to be provided. Impact on operator workload is determined by these choices.

Users have the opportunity to purchase up to two types of HSI analyses for this scenario: Task and Workload Analysis and Training Needs Analysis. Task and Workload Analysis defines critical information requirements and determines how visual workload is calculated through screen placement. Training Needs Analysis measures the workload associated with each potential operator's attributes and skill level.

Users have the option to choose up to six control station display screens. A description of each screen is shown in Figure 11.

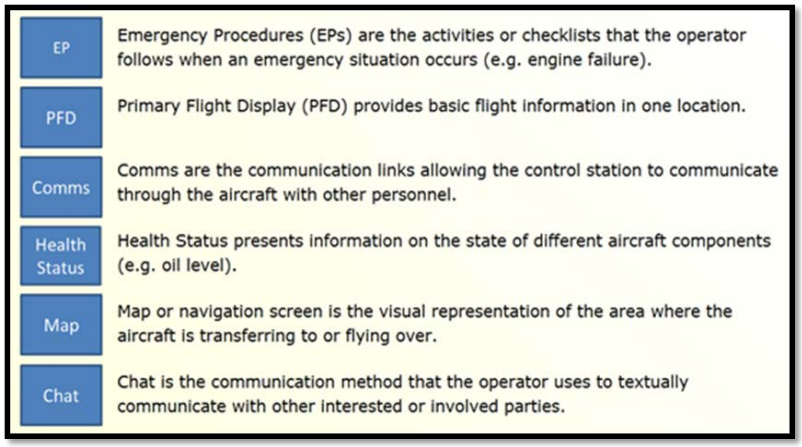


Figure 11 Display Screen Options

The user is then provided with the HSI-related analyses to provide information on the required display system capabilities. As part of the Task and Workload Analysis, the user discovers that the HSI team will conduct a cognitive task analysis to identify critical information requirements for UAS displays. Based on this cognitive task analysis, only four of the six screens are identified as visual workload drivers: primary flight display, moving map, communications, and emergency procedures. These four screens are included in the estimation of visual workload.

To facilitate matrix representation in the mathematical model, each of these mission critical tasks is given an index, as shown in Table 2:

Table 2 Task Index Assignments

Task	Index
Primary Flight Display	0
Moving Map	1
Communications	2
Emergency Procedures	3

The probability that the operator will transition between tasks (normally on separate screens) is a major driver in the visual workload. SURVIAC estimated the probability of transitioning between tasks as follows (Table 3):

Table 3 Transition Probability

Task	0	1	2	3
0	0.0000	0.6000	0.3000	0.1000
1	0.5000	0.0000	0.4000	0.1000
2	0.7000	0.2000	0.0000	0.1000
3	0.2000	0.2000	0.6000	0.0000

These probability values are notional for the purposes of the demonstration scenario and are assumed valid only in the context of the model.

Users are informed that increasing the number of display monitors also increases the visual workload for each operator. Available configurations for display monitors are shown in Figure 12.

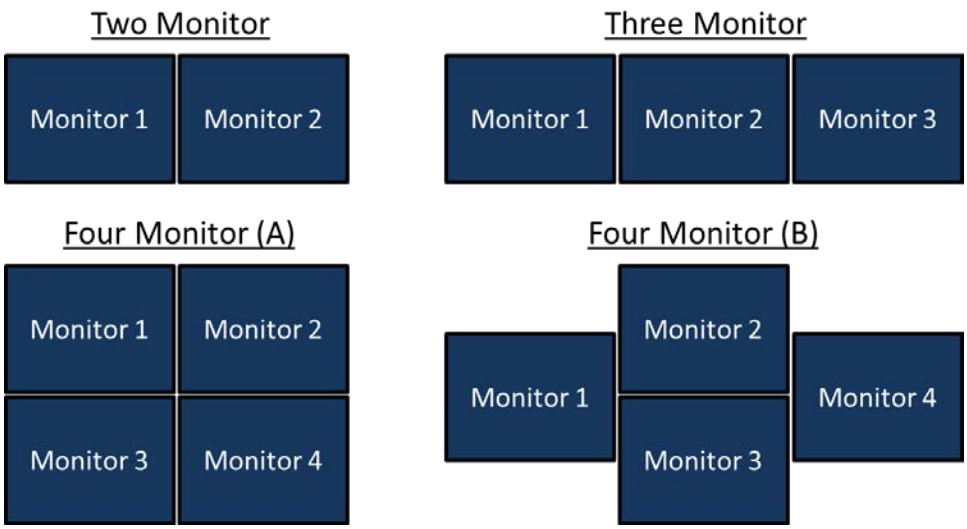


Figure 12 Screen Configuration

Measurement information for head/eye movement between displays and screens is presented. Distances between tasks are shown in Figure 13:

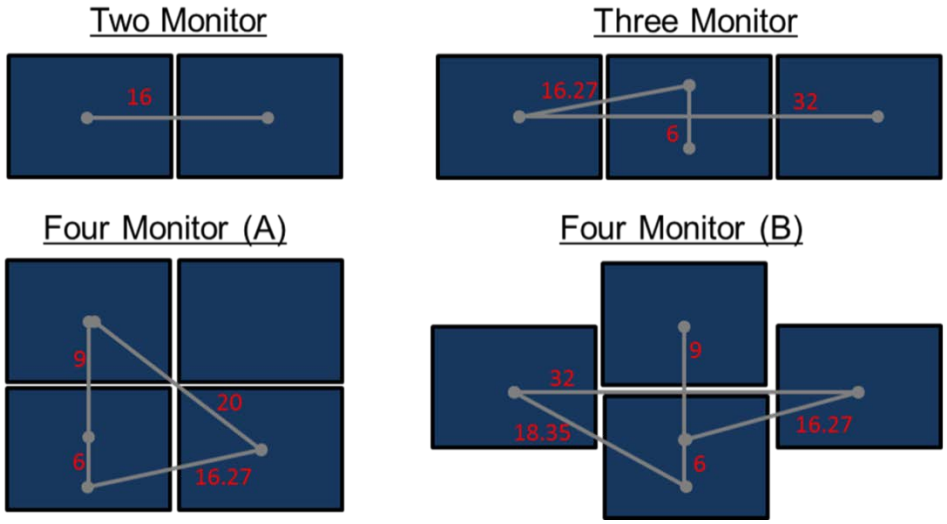


Figure 13 Distances between Tasks
(Note: Communications and health status tasks are combined on a single monitor)

In addition to the physical configuration, the layout of the tasks also impacts the distance between the tasks. A matrix of distances between tasks was calculated for every screen configuration and task layout combination. The two monitor configuration resulted in six distance matrices, the three monitor configuration resulted in 12 distance matrices, and the four monitor (both A and B) configurations resulted in 72 distance matrices. Screen layouts and corresponding distance matrices are located in Appendix D.

Time to transition between tasks is a function of distance between the tasks and is estimated in Equation 1, where $E[T_{ijk}]$ is the mean expected transition time between task *i* and task *j* for screen layout *k*, d_{ijk} is the distance between task *i* and task *j* for screen layout *k*, and *m* and *b* are constants.

$$E[T_{ijk}] = md_{ijk} + b \qquad \textbf{Equation 1}$$

The screen layout index *k* denotes the physical configuration of the monitors (2, 3, or 4), and the layout of the tasks on the screens. Constants *m* and *b* are identical between monitor configuration and task layout, with *m* set to a value of 1 and *b* to a value of 0 for demonstration purposes. The constants can be adjusted to model more realistic transition times based on regression of human head/eye movement. The mathematical model is structured so that placing tasks with a high probability of transition on screens further from each other results in a higher visual workload.

The Training Needs Analysis provides users with three potential operator pools, each having a different initial skill level (aptitude). Operators must obtain additional training to effectively operate the UAS. Three discrete values are available for both training time and operator aptitude. Training time varies between 50, 100, and 150 hours. Operators with a skill level similar to that of an experienced gamer are assigned aptitude values of 45, sport pilot skill levels are assigned an aptitude value of 60, and commercial pilot skill levels are assigned an aptitude value of 75. Completion time for each task is a function of aptitude and training time and can be estimated using Equation 2 (based on the power law of practice):

$$E[T_i] = a_i N^{-b_i} + X \qquad \textbf{Equation 2}$$

where a_i and b_i are constants for task *i*, *N* is training time, and *X* is operator aptitude. The values were selected to yield a wide range of possible task completion times. Constants a_i and b_i are selected so that the completion time for each task follows the expected trend that higher training times and aptitude values result in lower task completion times. For the purposes of the demonstration model, the constants are assumed to be identical between tasks. Constants can be refined to more realistically model the impact of training and aptitude on operator performance. A plot of task completion times using the notional training times, aptitudes, and constants can be seen in Figure 14:

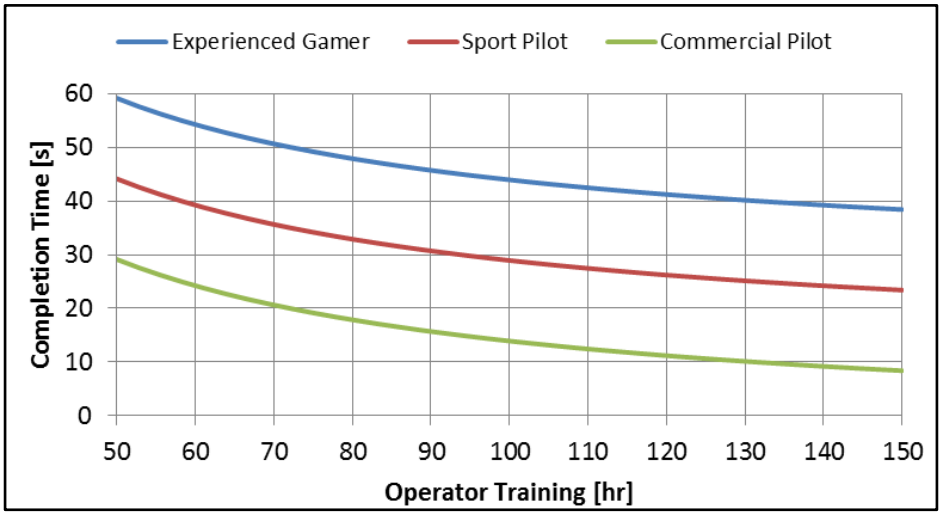


Figure 14 Expected Task Completion Time

The task completion times are clearly offset to show the impact of aptitude. A limiting probability is calculated to determine the long-term probability that the operator will be in a given task when starting to transition to another task (Table 4).

Table 4 Limiting Probability

Task	Limiting Probability
Primary Flight Display	0.3516
Moving Map	0.2839
Communications	0.2736
Emergency Procedures	0.0909

Since the limiting probabilities are calculated from the transition matrix in Table 3, these values were also notional and assumed valid only in the context of the model. The mathematical model is structured so that tasks with a high limiting probability and a high completion time result in a higher workload.

Upon completion of the HSI-related analyses, the user designs the UAS display system, choosing the number of monitors, layout, type of operator (aptitude), and amount of training. The workload is calculated for each combination of monitor configuration, screen layout, operator training, and operator aptitude using Equation 3:

$$\boldsymbol{E[W] = \sum_{i=0}^{3} \left(\pi_i E[T_i] \left(\sum_{i=0}^{3} P_{ij} E\left[T_{ijk}\right] \right) \right)} \qquad \textbf{Equation 3}$$

where $E[W]$ is the expected workload, π_i is the limiting probability for task *i* (Table 3), $E[T_i]$ is the expected completion time of task *i* (Eq 2), P_{ij} is probability of transitioning from task *i* to task *j* (Table 2), and $E\left[T_{ijk}\right]$ is the expected transition time between task *i* and task *j* for screen layout *k* (Eq 1). An example of the estimated workload calculations can be seen in Figure 15:

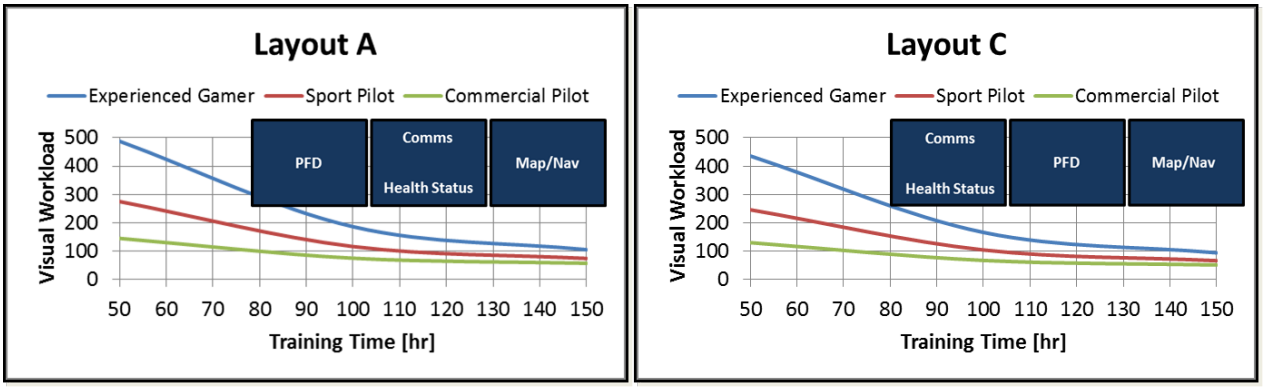


Figure 15 Example Workload Output

Figure 15 shows a comparison of the estimated workload as a function of screen layout, aptitude, and training. Due to the closer proximity of the highest probability tasks (primary flight display and moving map), the estimated workload for Layout C is lower than Layout A. Additionally, the workload dramatically reduces as longer training times are used for operators with lower initial aptitudes. At a training time of 150 hours, the visual workloads for each type of operator approach a single value. The plots also illustrate the diminishing returns of longer training times for operators with a high initial aptitude (commercial pilot). The mathematical model captures the desired visual workload behavior, based on the calculations for the complete set of configuration, layout, training, and aptitude input variables. To succeed or "pass" this scenario, the user must have spent less than $3M and have an acceptable level of workload. Within the context of the scenario, an acceptable average workload level is defined as 70-80%. The user is rewarded with an animated graphic depicting his/her success or failure to meet the requirements.

4.0 User Testing

SURVIAC performed two user tests of the HSI Tradeoff Demonstration Model. The first test, conducted February/March 2012, focused on an early prototype of the model. Six users from SURVIAC and 711 HPW/HP participated in this test. The results were used to make improvements to the final version of the model, which was evaluated by six users in June 2012 (five of these had participated in the first test.) Each test session consisted of pre- and post-testing of users' HSI domain knowledge, a model walk-through, and the completion of a user survey assessing the model's usability.

4.1 Training Effectiveness

At the beginning of each test session, SURVIAC administered a pre-test (Appendix E) to identify users' starting knowledge about the HSI domains. At the end of each session, a post-test, consisting of the same questions was given. By comparing results, it was possible to determine if the model provided information transfer to the users. The multiple choice pre- and post-tests focused on the ability of the participants to:

- Understand and identify the nine different Air Force HSI domains
- Understand the definition of HSI
- Understand the importance of HSI analyses
- Understand the criticality and difficulty of performing HSI-related tradeoffs

In general, the users who participated in the study exhibited a relatively good understanding of HSI domains on the pre-test. That fact, along with the small number of participants precludes any significant conclusions about the model's training effectiveness. However, in both sessions, the post-test results showed an improvement in the number of correct answers.

4.2 Model Walk-Through and Usability Assessment

After completing the HSI knowledge pre-test, participants were provided with an electronic questionnaire (Appendix G) to collect background information and to guide their evaluation of the model. A model walk-through was performed by each user while the SURVIAC model development team observed. The users evaluated the functionality and usability of the model in understanding the goal of HSI and the importance of performing HSI-related tradeoffs. A five-point Likert scale was used to identify users' satisfaction or agreement with each usability assessment question; one represented the low or negative end of the scale and five represented the high or positive end of the scale. In addition to the rating scale, the SURVIAC team requested the users provide comments or additional feedback to explain the numerical rating. An example of the rating scale is provided in Figure 16.

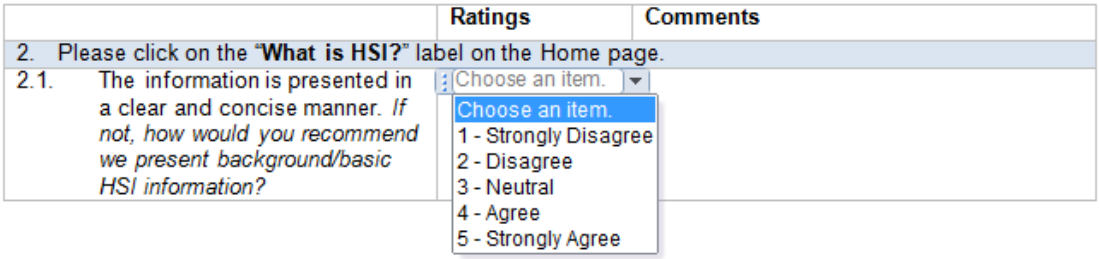


Figure 16 Usability Test 1 Rating Scale

During the first user test, the SURVIAC team identified additional opportunities to improve the background HSI information and the presentation of the TSA and UAS scenarios. The second test was used to validate and confirm usability and content of the model. Feedback from the second test focused

on grammatical and software errors and the recommendation to add a screen (Figure 17) discussing the importance and difficulty of conducting tradeoffs.

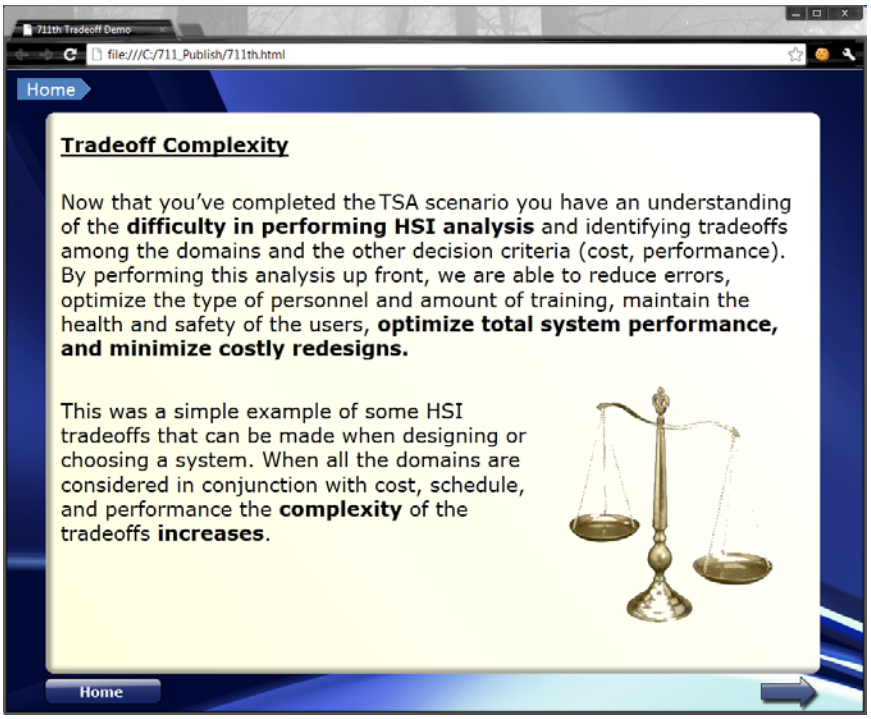


Figure 17 Tradeoff Complexity Screen

The critical feedback from this usability testing indicated that the tool and scenarios were useful in identifying HSI related tradeoffs for different types of systems. The test participants found that the analysis provided additional information to assist with decision making.

5.0 Summary

The HSI Tradeoff Model was developed by SURVIAC as a tool to educate program managers and systems engineering professionals about Human Systems Integration and its importance within the Air Force's life cycle management processes.

In addition to providing a greater understanding of HSI concepts, the model demonstrates the importance of HSI tradeoffs and how the nine HSI domains interface with each other and the systems engineering functions of cost, schedule, and performance.

The HSI Tradeoff Model consists of one tutorial and two scenario-based concept application modules that allow the user to apply basic HSI analysis information, explore options, and make decisions about the design and acquisition of a new system that will potentially enhance the personnel and system performance and survivability. It provides a graphical, interactive representation of the tradeoffs involved in incorporating HSI concepts into the life cycle management process.

By providing this model to program managers and systems engineering professionals, the 711 HPW/HP further advances an understanding of concepts essential to Department of Defense and Air Force life cycle management processes. These concepts, when applied effectively, will have both an immediate and long-term effect on personnel and system performance and survivability.

Appendix A: Acronyms

711 HPW/HP	711th Human Performance Wing/Human Systems Integration Directorate
AF	Air Force
DoDI	Department of Defense Instruction
EP	Emergency Procedure
HSI	Human Systems Integration
PFD	Primary Flight Display
SURVIAC	Survivability Vulnerability Information Analysis Center
TSA	Transportation Security Administration
UAS	Unmanned Aircraft System
USAF	United States Air Force

Appendix B: References

United States Department of Defense (2013). Interim Department of Defense Instruction 5000.02, Operation of the Defense Acquisition System. Washington DC: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, USD (AT&L).

Appendix C: Model Installation and Operation Requirements

The HSI Tradeoff Demonstration model requires the following for optimal use:

- **Operating System:** Windows XP SP2, Windows Vista, Windows 7, Mac OS X 10.4.8 or above.
- **Processor:** Windows: Intel Pentium III or higher, Mac: Intel Core Duo.
- **Memory:** 128 MB or greater
- **Software:** Silverlight 4.0 or higher, installation can be found at http://www.microsoft.com/getsilverlight/Get-Started/Install/Default.aspx
- **Screen Resolution:** 1280 x 768 or higher otherwise you might notice some parts of the application being cut off. If this is the case, follow the directions on the first page of the application to resolve the issue.

To open the stand-alone version of the 711th Tradeoff Demo model, double click on the '711th.html' file (Figure 18). A browser window should open with the application.

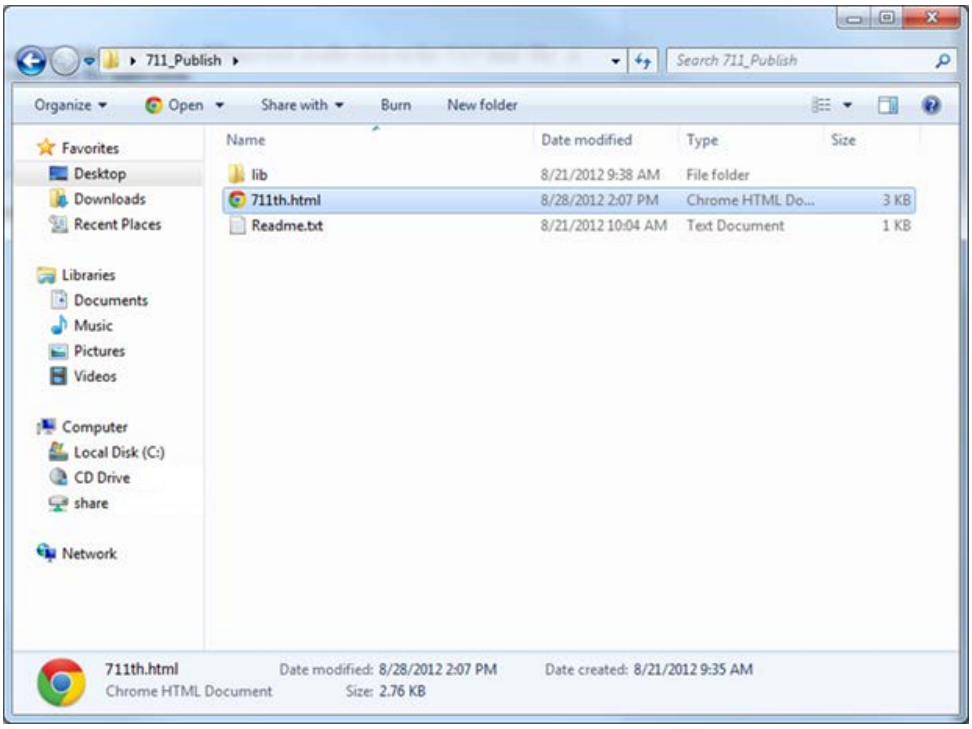


Figure 18 Opening the Application

Appendix D: Scenario Equations and Calculations

The Design Scenario calculations and TSA Scenario calculations spreadsheets are available upon request.

Two Screen Layout Work Data

Gamer					Sport Pilot					Commercial Pilot				
Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work
A	16626	8388	6172	X	A	9524	5175	4018	X	A	3969	2054	1563	X
B	17346	8751	6440		B	9937	5399	4192		B	4140	2143	1631	
C	16626	8388	6172	X	C	9524	5175	4018	X	C	3969	2054	1563	X
D	20492	10338	7608		D	11739	6379	4952		D	4891	2532	1926	
E	20492	10338	7608		E	11739	6379	4952		E	4891	2532	1926	
F	17346	8751	6440		F	9937	5399	4192		F	4140	2143	1631	

Three Screen Layout Work Data

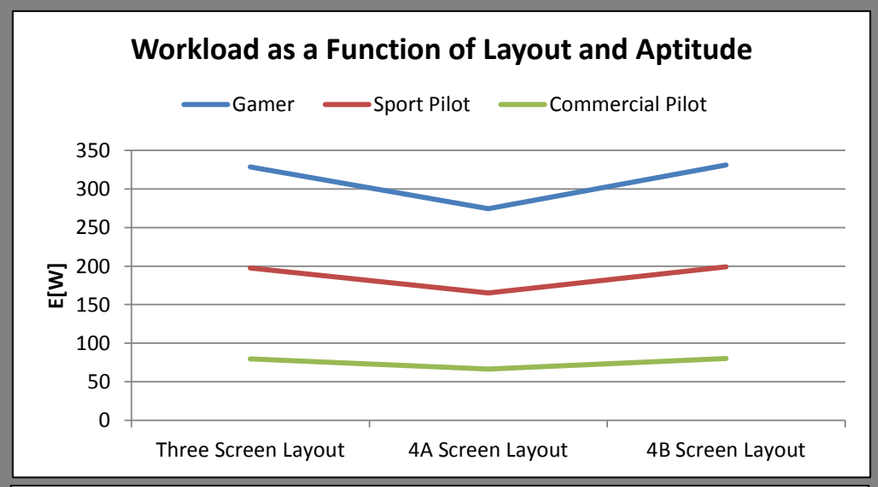
Gamer					Sport Pilot					Commercial Pilot				
Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work
A	590	298	219		A	338	184	143		A	141	73	55	
B	589	297	218		B	337	183	142		B	140	73	55	
C	526	265	195	X	C	301	164	127	X	C	125	65	49	X
D	526	265	195	X	D	301	164	127	X	D	125	65	49	X
E	589	297	218		E	337	183	142		E	140	73	55	
F	590	298	219		F	338	184	143		F	141	73	55	

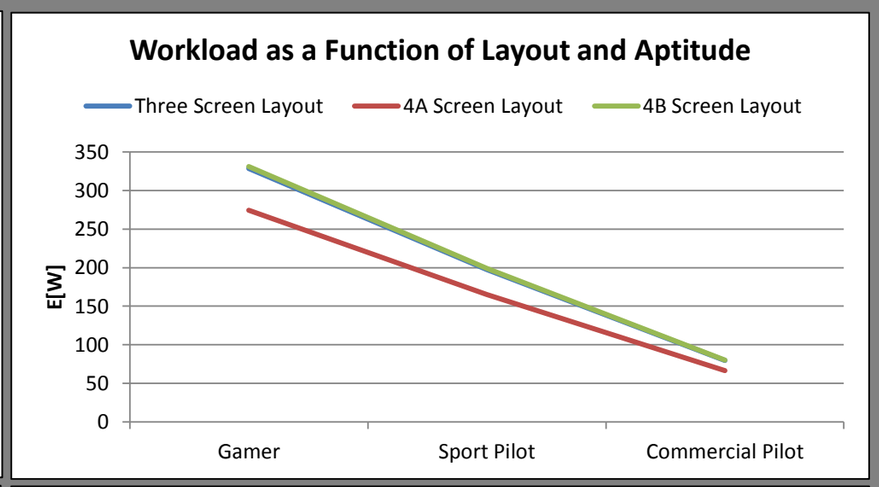
4A Screen Layout Work Data

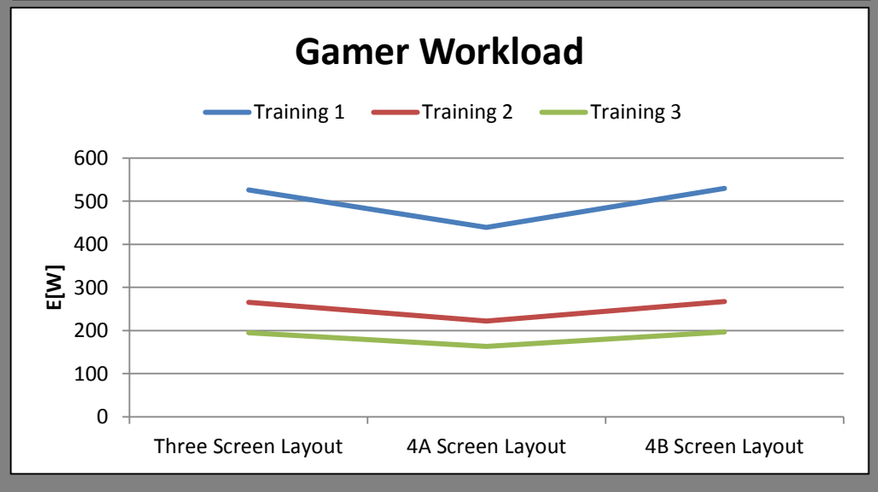
Gamer					Sport Pilot					Commercial Pilot				
Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work
A	489	247	181		A	280	152	118		A	117	60	46	
B	478	241	177		B	274	149	116		B	114	59	45	
C	450	227	167		C	258	140	109		C	107	56	42	
D	475	239	176		D	272	148	115		D	113	59	45	
E	453	229	168		E	260	141	110		E	108	56	43	
F	439	222	163	X	F	252	137	106	X	F	105	54	41	X
G	453	229	168		G	260	141	110		G	108	56	43	
H	439	222	163	X	H	252	137	106	X	H	105	54	41	X
I	489	247	181		I	280	152	118		I	117	60	46	
J	478	241	177		J	274	149	116		J	114	59	45	
K	450	227	167		K	258	140	109		K	107	56	42	
L	475	239	176		L	272	148	115		L	113	59	45	
M	450	227	167		M	258	140	109		M	107	56	42	
N	475	239	176		N	272	148	115		N	113	59	45	
O	453	229	168		O	260	141	110		O	108	56	43	
P	439	222	163	X	P	252	137	106	X	P	105	54	41	X
Q	489	247	181		Q	280	152	118		Q	117	60	46	
R	478	241	177		R	274	149	116		R	114	59	45	
S	450	227	167		S	258	140	109		S	107	56	42	
T	475	239	176		T	272	148	115		T	113	59	45	
U	453	229	168		U	260	141	110		U	108	56	43	
V	439	222	163	X	V	252	137	106	X	V	105	54	41	X
W	489	247	181		W	280	152	118		W	117	60	46	
X	478	241	177		X	274	149	116		X	114	59	45	

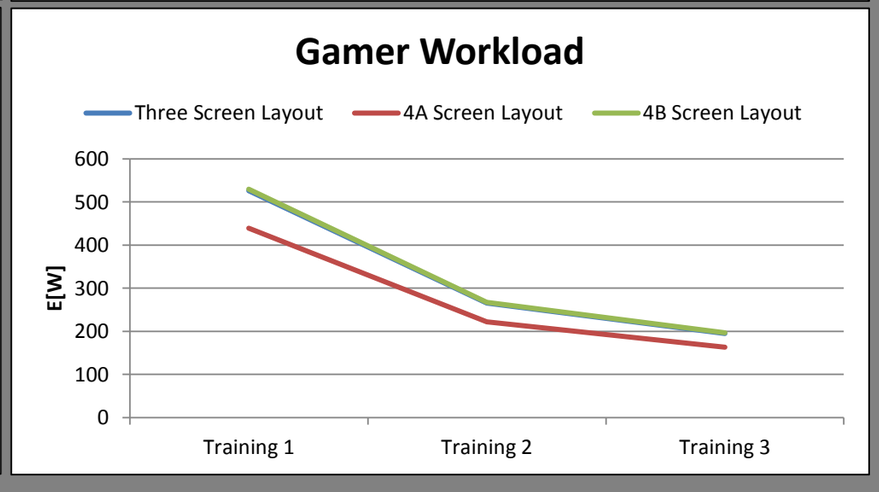
4B Screen Layout Work Data														
Gamer					Sport Pilot					Commercial Pilot				
Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work	Layout	270000	540000	720000	Min Work
A	704	355	261		A	403	219	170		A	168	87	66	
B	690	348	256		B	395	215	167		B	165	85	65	
C	563	284	209		C	322	175	136		C	134	70	53	
D	704	355	261		D	403	219	170		D	168	87	66	
E	690	348	256		E	395	215	167		E	165	85	65	
F	563	284	209		F	322	175	136		F	134	70	53	
G	530	267	197	X	G	304	165	128	X	G	126	65	50	X
H	636	321	236		H	364	198	154		H	152	79	60	
I	704	355	261		I	403	219	170		I	168	87	66	
J	530	267	197	X	J	304	165	128	X	J	126	65	50	X
K	636	321	236		K	364	198	154		K	152	79	60	
L	704	355	261		L	403	219	170		L	168	87	66	
M	563	284	209		M	322	175	136		M	134	70	53	
N	531	268	197	X	N	304	165	128	X	N	127	66	50	X
O	530	267	197	X	O	304	165	128	X	O	126	65	50	X
P	563	284	209		P	322	175	136		P	134	70	53	
Q	531	268	197	X	Q	304	165	128	X	Q	127	66	50	X
R	530	267	197	X	R	304	165	128	X	R	126	65	50	X
S	636	321	236		S	364	198	154		S	152	79	60	
T	531	268	197	X	T	304	165	128	X	T	127	66	50	X
U	690	348	256		U	395	215	167		U	165	85	65	
V	636	321	236		V	364	198	154		V	152	79	60	
W	531	268	197	X	W	304	165	128	X	W	127	66	50	X
X	690	348	256		X	395	215	167		X	165	85	65	

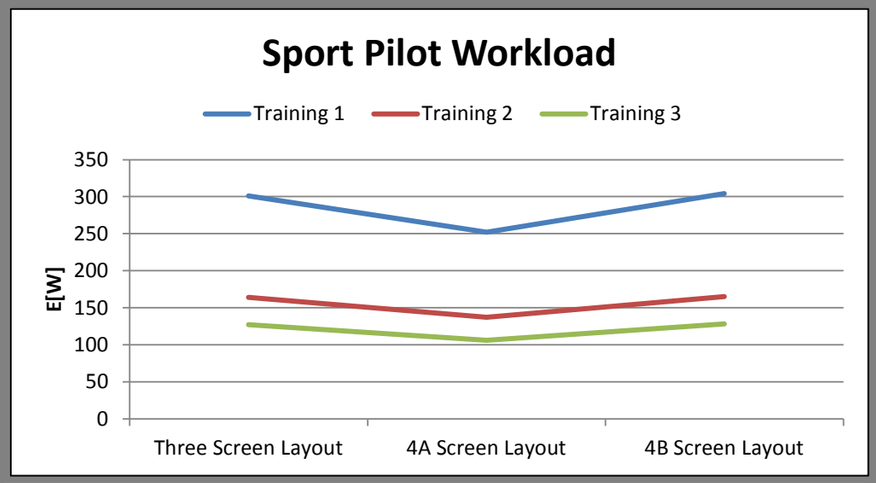
Two Screen Layout											
Gamer				Sport Pilot				Commercial Pilot			
Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg
16626	8388	6172	10395	9524	5175	4018	6239	3969	2054	1563	2529
Three Screen Layout											
Gamer				Sport Pilot				Commercial Pilot			
Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg
526	265	195	329	301	164	127	197	125	65	49	80
4A Screen Layout											
Gamer				Sport Pilot				Commercial Pilot			
Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg
439	222	163	275	252	137	106	165	105	54	41	67
4B Screen Layout											
Gamer				Sport Pilot				Commercial Pilot			
Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg	Training 1	Training 2	Training 3	Avg
530	267	197	331	304	165	128	199	126	65	50	80

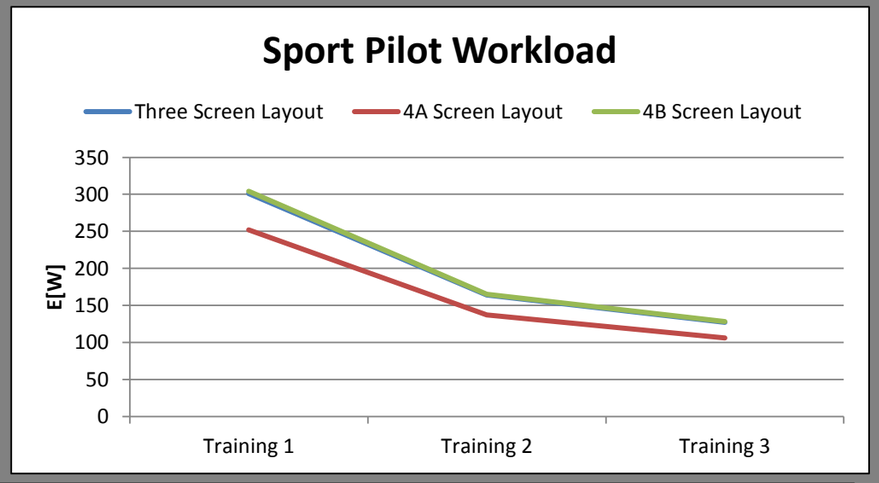


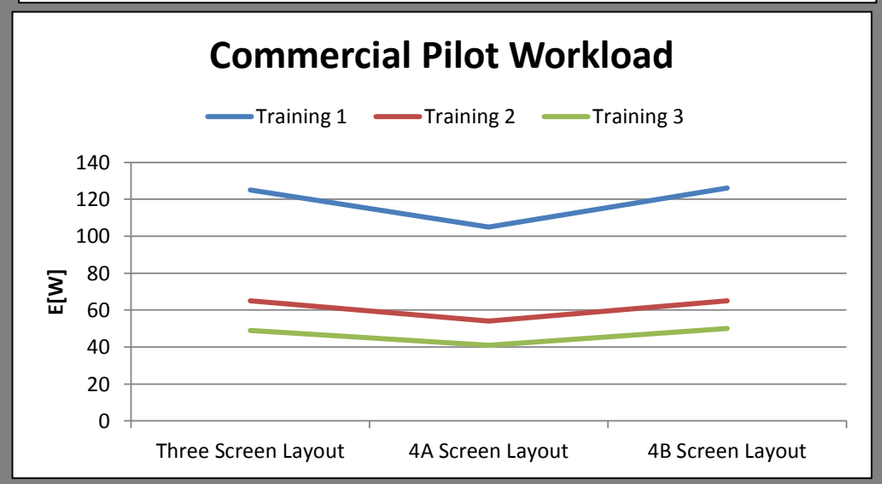


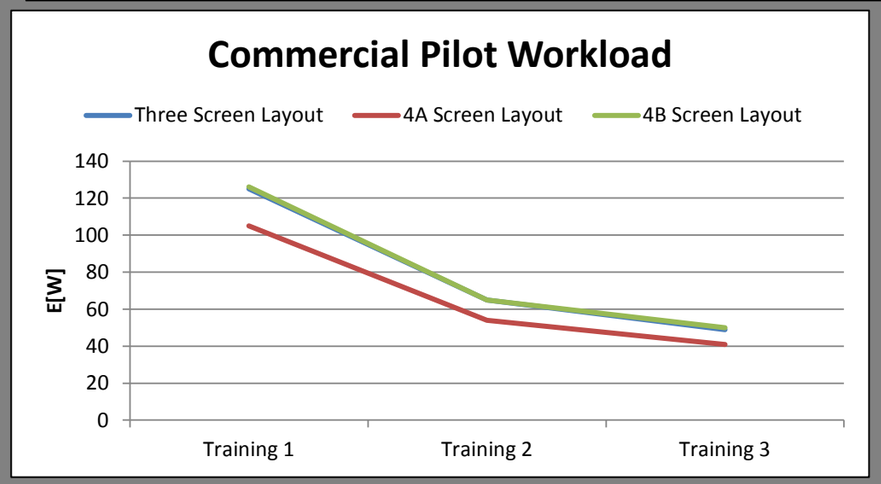





Sport Pilot Workload
Training 1
Training 2
Training 3
E[W]
350
300
250
200
150
100
50
0
Three Screen Layout
4A Screen Layout
4B Screen Layout


Sport Pilot Workload
Three Screen Layout
4A Screen Layout
4B Screen Layout
E[W]
350
300
250
200
150
100
50
0
Training 1
Training 2
Training 3


Commercial Pilot Workload
Training 1
Training 2
Training 3
E[W]
140
120
100
80
60
40
20
0
Three Screen Layout
4A Screen Layout
4B Screen Layout


Commercial Pilot Workload
Three Screen Layout
4A Screen Layout
4B Screen Layout
E[W]
140
120
100
80
60
40
20
0
Training 1
Training 2
Training 3

	System A (Touchless Invader)					System B (Spinex)				
System	Training Hrs	Personnel Aptitude	Throughput	Reliability (%)	Initial Cost (1yr)	Training Hrs	Personnel Aptitude	Throughput	Reliability (%)	Initial Cost (1yr)
A	16	100	60	97	$ 21,532,000	16	100	50	98	$ 19,798,000
A	40	100	60	97	$ 21,580,000	40	100	50	98	$ 19,870,000
A	40	80	60	97	$ 21,180,000	40	80	50	98	$ 19,270,000
A	60	100	60	97	$ 21,620,000	60	100	50	98	$ 19,930,000
A	60	80	60	97	$ 21,220,000	60	80	50	98	$ 19,330,000
A	60	60	60	97	$ 20,820,000	60	60	50	98	$ 18,730,000

HSI Marketing Demonstration Tradeoff Tool: PRE-TEST

Please complete the questions below.

Name:			
Date:	**6/25/2012**		
1.1.	Match the following terms with the appropriate definition. A. Training B. Personnel C. Human Factors Engineering D. Manpower E. Safety F. Occupational Health	Choose an item.	Design for/around the human
		Choose an item.	Prevent long term injuries and disabilities
		Choose an item.	Number of spaces or billets
		Choose an item.	Skill enhancement
		Choose an item.	Mishap and injury prevention
		Choose an item.	Types of faces
1.2.	HSI is… A. Human Systems Interaction B. Human Factors Engineering C. Human Systems Integration D. Human Systems Interdependence	Choose an item.	
1.3.	HSI in the Air Force has _____ domains	1.	Choose an item.
1.4.	HSI identifies interdependencies and tradeoffs among… 2.	3.	Choose an item.
1.5.	HSI helps to ensure that the human is considered on par with the hardware and software during system design and development.	4.	Choose an item.
1.6.	Performing HSI activities supports increased human performance	5.	Choose an item.
1.7.	Effective consideration of HSI helps to reduce total ownership costs and safety mishaps. 6.	7.	Choose an item.

HSI Marketing Demonstration Tradeoff Tool: POST-TEST

Please complete the questions below.

Name:			
Date:	**6/25/2012**		
1.8.	Match the following terms with the appropriate definition. G. Training H. Personnel I. Human Factors Engineering J. Manpower K. Safety L. Occupational Health	Choose an item.	Design for/around the human
		Choose an item.	Prevent long term injuries and disabilities
		Choose an item.	Number of spaces or billets
		Choose an item.	Skill enhancement
		Choose an item.	Mishap and injury prevention
		Choose an item.	Types of faces
1.9.	HSI is… E. Human Systems Interaction F. Human Factors Engineering G. Human Systems Integration H. Human Systems Interdependence	Choose an item.	
1.10.	HSI in the Air Force has _____ domains	8.	Choose an item.
1.11.	HSI identifies interdependencies and tradeoffs among… 9.	10.	Choose an item.
1.12.	HSI helps to ensure that the human is considered on par with the hardware and software during system design and development.	11.	Choose an item.
1.13.	Performing HSI activities supports increased human performance	12.	Choose an item.
1.14.	Effective consideration of HSI helps to reduce total ownership costs and safety mishaps. 13.	14.	Choose an item.

Human Systems Integration Marketing Demonstration Tradeoff Tool

Section 1: Background Information

The information you provide in this section is for statistical purposes only. We ask that you provide your name and answer the following background/demographic questions.

Name:		
		Comments
1. Background/Demographics		
1.15. Do you work in the field of HSI? If yes, please describe activities.	2. Choose an item.	
3. 1.2 Are you familiar with the domains of Air Force HSI?	4. Choose an item.	
5. 1.3 Are you government or contractor?	6. Choose an item.	
7. 1.4 Have you participated in developing marketing tools or materials in the past? If yes, for what industry.	8. Choose an item.	

Section 2: Time

Please record your start and end times. Start with the "What is HSI?" link and continue to the TSA Scenario.
Demonstration Link: http://www.bahdayton.com/711th

Time Initiated: From scenario initiation	9.
Time Completed: Results screen	10.

Section 3: Usability/Tasks Walkthrough

Please read the instructions below and provide your feedback on the tasks as they are completed. For this section of the questionnaire, you will go through an example scenario of identifying HSI-related tradeoffs.

Please rate the applicable statements on a 5-point scale with **1 representing the low or negative end** of the scale and **5 as the high or positive end** of the scale and provide comments to support your rating.

	Ratings	**Comments**
2. Please click on the "**What is HSI?**" label on the Home page.		
2.1. The information is presented in a clear and concise manner. *If not, how would you recommend we present background/basic HSI information?*	11. Choose an item.	
2.2. The definition of HSI accurately represents the functions	12. Choose an item.	

	(domains) of HSI.		
2.3.	When each domain is “moused-over” the phrase identified on the ‘bumper sticker’ effectively identifies the meaning (definition or function) of that area.	13. Choose an item.	
2.4.	Each domain definition and example slide accurately reflects the domain.	14. Choose an item.	15.
2.5.	The page displaying all of the domain definitions clearly and accurately shows the differences between each domain.	16. Choose an item.	17.
2.6.	Based on the information presented in this section, what is the goal of HSI?		
2.7.	Do you have any recommendations for improvement?		
3. Please click on the **TSA Scenario** button.			
3.1.	The scenario description was informative.	18. Choose an item.	
4. Please move on to the **Introduction** screen by clicking on the forward arrow at the bottom right of the screen.			
4.1.	The task is clearly and concisely stated. If not, please explain.	19. Choose an item.	
4.2.	I understand my goals and objectives for this task. *What are the goals and objectives?*	20. Choose an item.	
5. Please move on to the **Systems** screen by clicking on the forward arrow at the bottom right of the screen.			
5.1	I understand the three pieces of data I was provided for each system (cost, required manpower, passenger throughput). If not, please explain.	21. Choose an item.	
22.	5.2 The overarching objectives in choosing a system were easy to understand. *Please identify your overarching objectives in choosing a system.*	23. Choose an item.	
6. Please move on to the **Analysis** screen by clicking on the forward arrow at the bottom right of the screen.			
6.1	I understand the importance of performing HSI analysis to	24. Choose an item.	

	assist in identifying the optimal solution. If not, please explain.		
25.	6.2 I understand what will be provided if I purchase HSI analysis. *What will HSI analysis provide to your decision making?*	26. Choose an item.	
6.3	Please identify what type(s) of HSI analysis you purchased.	27. Choose an item.	
7.	If you chose to purchase HSI Analysis please move on to the **Personnel and Training Needs Analysis** screen by clicking on the forward arrow at the bottom of the right screen.		
7.1	Did you purchase Personnel and Training Needs Analysis? *Why?*	28. Choose an item.	
7.2	The Personnel and Training Needs Analysis identified that personnel skills and required training are indirectly proportional.	29. Choose an item.	
7.3	The graph accurately represents the relationship between the aptitude scores and the required training.	30. Choose an item.	
7.4	I can effectively translate the Personnel and Training Needs Analysis into my decision making for choosing a new scanning system. *If not, please explain.*	31. Choose an item.	
8.	If you chose to purchase HSI analysis please move on to the **Throughput and Manpower Analysis** screen by clicking on the forward arrow at the bottom right of the screen.		
8.1	Did you purchase Throughput and Manpower Analysis? *Why?*	32. Choose an item.	
33.	8.2 I understand how throughput and manpower will affect the total operating cost. If not, please explain.	34. Choose an item.	
35.	8.3 I understand the data represented on each graph showing the relationship between the throughput and skill level to meet the required detection rate. If not, please explain.	36. Choose an item.	
37.	8.4 I understand that based on operator skill level I will need a different number of systems to achieve required throughput. If not, please explain.	38. Choose an item.	
9.	Please move onto the **Training** screen by clicking on the forward arrow at the bottom right of the screen. You have reached the screen where you will begin making tradeoff decisions on the different domains in order to accomplish your overall goals. Please read the information presented at the top of the screen and choose Personnel and Training options.		

9.1.	Enough information is presented for me to make a decision on the aptitude scores an individual may need. *If not, what additional information would allow you to make a more informed decision?*	39. Choose an item.	
9.2.	Enough information is presented for me to make a decision on the amount of training hours an individual may need. *If not, what additional information would allow you to make a more informed decision?*	40. Choose an item.	
10. Please move on to the **Selection** screen by clicking on the forward arrow at the bottom right of the screen. Please read the information presented at the top of the screen.			
10.1.	Based on the training and personnel decisions you made on the previous screen, it was difficult to determine the appropriate equipment to meet overall scenario goals.	41. Choose an item.	
11. Please move on to the **Review** screen by clicking on the forward arrow at the bottom right of the screen. Please review the selections you have made.			
11.1.	Do all of the selections that you previously choose appear? *If not, what is not accurately represented?*	42. Choose an item.	
11.2.	Did you go back to a screen and make changes*. If so, what screen? What change did you make?*	43. Choose an item.	
11.3.	What Personnel choice did you make?	44. Choose an item.	
11.4.	What Training choice did you make?	45. Choose an item.	
11.5.	What System did you chose?	46. Choose an item.	
12. Please move on to the **Results** screen by clicking on the forward arrow at the bottom right of the screen. Please review results of your tradeoff decisions			
12.1.	The resulting information was what I expected. *If not, why? What did you expect?*	47. Choose an item.	
12.2.	Did your system meet all the goals and objectives?	48. Choose an item.	
12.3.	If not, what goal(s) didn't you meet?	49. Choose an item.	
12.4.	If you purchased HSI analysis, did the information provided assist you in making a decision?	50. Choose an item.	
12.5.	With the information provided	51. Choose an item.	

	would you be able to go back and make a better informed decision if you were to go through the scenario again?		
12.6.	What different tradeoffs would you make in the future?		
13. Please move on to the **Solutions** screen by clicking on the forward arrow at the bottom right corner.			
13.1.	This screen accurately represents the optimized solution.	52. Choose an item.	
13.2.	I understand the difference in the procurement and operating costs.	53. Choose an item.	
13.3.	Why is this solution optimal?		
13.4.	Please provide any additional comments/recommendations for improvement on the tool and scenario.		
14. Please click on the **UAS Scenario** button.			
14.1.	The scenario description was informative.	54. Choose an item.	
15. Please proceed to the next screen by clicking on the forward arrow at the bottom right.			
15.1	I understand the task objectives. *What are the objectives?*	55. Choose an item.	
16. Please proceed to the **Introduction** screen by clicking on the forward arrow at the bottom right.			
16.1.	I understand the UAS scenario goals. *What are the goals?*	56. Choose an item.	
16.2.	Acceptable workload is easily understood in the context of this scenario.	57. Choose an item.	
17. Please proceed to the next **Introduction** screen by clicking on the forward arrow at the bottom right.			
17.1.	The three design tasks I'm expected to perform within this scenario are clearly identified. *Please list the tasks.*	58. Choose an item.	
17.2.	Enough background information is presented to assist in making HSI tradeoffs for UAS control station design and operations. *If not, please explain.*	Choose an item.	
18. Please proceed to the **Screens** screen by clicking on the arrow at the bottom right.			
18.1	I understand the screens available for inclusion in the design.	Choose an item.	
18.2	Each definition is easily understood and clearly represents the design element. *If not, please explain.*	Choose an item.	
19. Please proceed to the **Analysis** screen by clicking on the forward arrow at the bottom right.			
59.	19.1 I understand the importance of performing HSI analysis to assist in identifying	60. Choose an item.	

	the optimal solution. If not, please explain.		
19.2	I understand what will be provided if I purchase HSI analysis. *What will HSI analysis provide to your decision making?*	61. Choose an item.	
19.3	Please identify what type(s) of HSI analysis you purchased.	62. Choose an item.	
20. If you chose to conduct Task and Workload Analysis please proceed to the **Task and Workload Analysis** screens by clicking on the forward arrow in the bottom right.			
20.1	Did you purchase Task and Workload Analysis? *Why?*	Choose an item.	
63.	20.2 I understand the definition of task analysis.	Choose an item.	
20.3	Please identify the role of the cognitive task analysis in redesigning the UAS displays.		
21. Please proceed to the next **Task and Workload Analysis** screen by clicking on the forward arrow in the bottom right.			
21.1	I understand the definition of workload and how maintaining situation awareness will affect the workload. *If not, please explain.*	Choose an item.	
22. Please proceed to the next **Task and Workload Analysis** screen by clicking on the forward arrow in the bottom right.			
22.1	The mission critical tasks are clearly identified.	Choose an item.	
22.2	Please list the mission critical tasks that will be major design drivers.		
22.3	I understand the probability of each primary task occurring. *Please list the order of frequency.*	Choose an item.	
22.4	I can easily identify the relationships between these tasks and some of the design screens previously presented? *If, not please describe why.*	Choose an item.	
22.5	I understand each primary task that will be performed while operating a UAS. *If not, please identify which task(s) were not clearly described.*	Choose an item.	
22.6	Workload is a function of time and effort needed to complete the primary tasks.	Choose an item.	
23. Please proceed to the next **Task and Workload Analysis** screen by clicking on the forward arrow in the bottom right.			
23.1	I understand that visual workload is also defined by the	Choose an item.	

	distance and frequency of performing a task.		
23.2	How many monitor configuration options are available for designing the control station?	Choose an item.	
23.3	The information presented on Task and Workload Analysis will assist in designing the UAS displays. *If not, why?*	Choose an item.	
24. If you chose to purchase Training Needs Analysis, please proceed to the **Training Needs Analysis** screen by clicking on the arrow at the bottom right.			
24.1	Did you purchase Training Needs Analysis? *Why?*	Choose an item.	
24.2	This screen clearly identifies that aptitude score is indirectly proportional to the required training.	Choose an item.	
24.3	The minimum amount of training required for each operator is easily identified.	Choose an item.	
25. Please proceed to the next **Training Needs Analysis** screen by clicking on the arrow at the bottom right.			
25.1	The graph accurately portrays the relationship between the task completion time and the operator skill level.	Choose an item.	
26. Please proceed to the **Monitor** choices screen by clicking on the arrow at the bottom right. If you chose not to purchase HSI analysis this screen will directly follow the I**ntroduction** screens.			
26.1	I can easily choose a monitor configuration	Choose an item.	
26.2	Please identify what monitor configuration you chose.	Choose an item.	
27. Please proceed to the **Design** screen by clicking on the arrow at the bottom right.			
27.1.	The description clearly explains how to place the display screens within the monitors.	Choose an item.	
27.2.	Enough information is presented for me to optimize display design. *If not, please explain why.*	Choose an item.	
27.3.	Please list the screens you chose.		
28. Please proceed to the **Operators** screen by clicking on the forward arrow at the bottom right.			
28.1.	I understand the differences between each operator's background and skills. *If not, please explain.*	Choose an item.	
28.2.	Enough information is presented for me to choose an operator. *If not, please explain why.*	Choose an item.	
29. Please proceed to the **Training** screen by clicking on the forward arrow at the bottom right.			

29.1. Enough information is presented for me to make a decision on the amount of training hours an individual may need? *If not, what additional information would allow you to make a more informed decision?*	64. Choose an item.	
30. Please proceed to the **Review** screen by clicking on the forward arrow at the bottom right.		
30.1. Do all of the selections that you previously choose appear? *If not, what is not accurately represented?*	65. Choose an item.	
30.2. Did you go back to a screen and make changes*. If so, what screen? What change did you make?*	66. Choose an item.	
30.3. Please identify what monitor configuration you chose.	Choose an item.	
30.4. What operator choice did you make?	67. Choose an item.	
30.5. What training choice did you make?	68. Choose an item.	
31. Please proceed to the **Results** screen by clicking on the forward arrow at the bottom right.		
31.1. The resulting information was what I expected. *If not, why? What did you expect?*	69. Choose an item.	
31.2. Did your system meet all the goals and objectives?	70. Choose an item.	
31.3. If not, what goal(s) didn't you meet?	71. Choose an item.	
31.4. If you purchased HSI analysis, did the information provided assist you in making a decision?	72. Choose an item.	
31.5. With the results provided would you be able to go back and make a better informed decision if you were to go through the scenario again?	73. Choose an item.	
31.6. What different tradeoffs would you make in the future?		
32. Please proceed to the **Solutions** screen by clicking on the forward arrow at the bottom right.		
74. 32.1 This screen accurately represents the optimal solutions.	75. Choose an item.	
76. 32.2 I understand why all of these solutions are optimal.	Choose an item.	
77. 32.3 Why is this solution optimal?		
78. 32.4 Please provide any additional recommendations to improve this scenario or tool.		

33. General Usability			
33.1	The demo was easy to use and requires little instruction.	79. Choose an item.	
80.	33.2 The graphical information on the screen is easy to understand.	81. Choose an item.	
82.	33.3 It was easy to navigate through the screens.	83. Choose an item.	
84.	33.4 The textual information was easy to read and understand.	85. Choose an item.	
86.	33.5 The color scheme and design is aesthetically pleasing.	87. Choose an item.	
88.	33.6 The demo was designed to minimize the potential for software errors to occur.	89. Choose an item.	
34. HSI Understanding			
90.	34.1 I have a more thorough understanding of HSI domains.	91. Choose an item.	
92.	34.2 I have a better understanding of HSI tradeoffs.	93. Choose an item.	
94.	34.3 If I encountered a different scenario I would be able to identify potential HSI tradeoffs.	95. Choose an item.	
34.5	I am interested in additional information about HSI tradeoffs. If not, why?	96. Choose an item.	

Human Systems Integration Marketing Demonstration Tradeoff Tool

Section 1: Background Information

The information you provide in this section is for statistical purposes only. We ask that you provide your name and answer the following background/demographic questions.

Name:		
		Comments
5. Background/Demographics		
96.1. Do you work in the field of HSI? If yes, please describe activities.	15. Choose an item.	
96.2. Are you familiar with the domains of Air Force HSI?	16. Choose an item.	
96.3. Are you government or contractor?	17. Choose an item.	
96.4. Have you participated in developing marketing tools or materials in the past? If yes, for what industry.	18. Choose an item.	

Section 2: Time

Please record your start and end times. Start with the "What is HSI?" link and continue to the TSA Scenario.
Demonstration Link: http://www.bahdayton.com/711th

Time Initiated: From scenario initiation	19.
Time Completed: Results screen	20.

Section 3: Usability/Tasks Walkthrough

Please read the instructions below and provide your feedback on the tasks as they are completed. For this section of the questionnaire, you will go through an example scenario of identifying HSI-related tradeoffs.

Please rate the applicable statements on a 5-point scale with **1 representing the low or negative end** of the scale and **5 as the high or positive end** of the scale and provide comments to support your rating.

	Ratings	**Comments**
6. Please click on the "**What is HSI?**" label on the Home page.		
2.8. The information is presented in a clear and concise manner. *If not, how would you recommend we present background/basic HSI information?*	21. Choose an item.	

2.9.	The definition of HSI accurately represents the functions (domains) of HSI.	22. Choose an item.	
2.10.	When each domain is "moused-over" the phrase identified on the 'bumper sticker' effectively identifies the meaning (definition or function) of that area.	23. Choose an item.	
2.11.	Based on the information presented on this page, what is the goal of HSI?		
2.12.	Do you have any recommendations for improvement?		
7. Please click on the **TSA Scenario** button.			
3.2.	The scenario description was informative.	24. Choose an item.	
8. Please move on to the **Introduction** screen by clicking on the forward arrow at the bottom right of the screen.			
4.3.	The task is clearly and concisely stated. If not, please explain.	25. Choose an item.	
4.4.	I understand my goals and objectives for this task. *What are the goals and objectives?*	26. Choose an item.	
9. Please move on to the **Systems** screen by clicking on the forward arrow at the bottom right of the screen.			
5.1.	I understand the three pieces of data I was provided for each system. (cost, required manpower, passenger throughput). If not, please explain.	27. Choose an item.	
5.2.	The overarching goal in choosing a system was easy to understand. *Please identify your overarching goal in choosing a system*	28. Choose an item.	
10. Please move onto the **Training** screen by clicking on the forward arrow at the bottom right of the screen. You have reached the screen where you will begin making tradeoff decisions on the different domains in order to accomplish your overall goals. Please read the information presented at the top of the screen and choose Personnel and Training options.			
9.3.	Enough information is presented for me to make a decision on the aptitude scores an individual may need. *If not, what additional information would allow you to make a more informed decision?*	29. Choose an item.	
9.4.	Enough information is presented for me to make a	30. Choose an item.	

	decision on the amount of training hours an individual may need. *If not, what additional information would allow you to make a more informed decision?*		
11. Please move on to the **Selection** screen by clicking on the forward arrow at the bottom right of the screen. Please read the information presented at the top of the screen.			
10.2.	Based on the training and personnel decisions you made on the previous screen, it was difficult to determine the appropriate equipment to meet overall scenario goals.	31. Choose an item.	
12. Please move on to the **Review** screen by clicking on the forward arrow at the bottom right of the screen. Please review the selections you have made.			
11.6.	Do all of the selections that you previously choose appear? *If not, what is not accurately represented?*	32. Choose an item.	
11.7.	Did you go back to a screen and make changes*. If so, what screen? What change did you make?*	33. Choose an item.	
11.8.	What Personnel choice did you make?	34. Choose an item.	
11.9.	What Training choice did you make?	35. Choose an item.	
11.10.	What System did you chose?	36. Choose an item.	
13. Please move on to the **Results** screen by clicking on the forward arrow at the bottom right of the screen. Please review results of your tradeoff decisions			
12.7.	The resulting information was what I expected. *If not, why? What did you expect?*	37. Choose an item.	
12.8.	Did your system meet all the goals and objectives?	38. Choose an item.	
12.9.	If not, what goal(s) didn't you meet?	39. Choose an item.	
12.10.	With the information provided would you be able to go back and make a better informed decision if you were to go through the scenario again?	40. Choose an item.	
12.11.	What different tradeoffs would you make in the future?		
14. Please move on to the **Solutions** screen by clicking on the text located at the bottom left corner "Good Job" or "Didn't do so well?" Link.			
13.5.	This screen accurately represents the optimized solution.	41. Choose an item.	
13.6.	I understand the different in acquisition costs and life cycle	42. Choose an item.	

	costs.		
13.7.	Why is this solution optimal?		
13.8.	Please provide any additional comments/recommendations for improvement on the tool and scenario.		
15. General Usability			
11.1.	The demo was easy to use and requires little instruction.	43. Choose an item.	
11.2.	The graphical information on the screen is easy to understand.	44. Choose an item.	
11.3.	It was easy to navigate through the screens.	45. Choose an item.	
11.4.	The textual information was easy to read and understand.	46. Choose an item.	
11.5.	The color scheme and design is aesthetically pleasing.	47. Choose an item.	
11.6.	The demo was designed to minimize the potential for software errors to occur.	48. Choose an item.	
16. HSI Understanding			
12.1.	I have a more thorough understanding of HSI domains.	49. Choose an item.	
12.2.	I have a better understanding of HSI tradeoffs.	50. Choose an item.	
12.3.	If I encountered a different scenario I would be able to identify potential HSI tradeoffs.	51. Choose an item.	
12.4.	I am interested in additional information about HSI tradeoffs. If not, why?	52. Choose an item.	

Appendix I: Usability Test Artifacts – HSI Tradeoff Tool User Test Feedback

The User Feedback spreadsheet is available upon request.

Test Subject	2	3	5	6
Pre-Tests				
1.1 Match the following terms with the appropriate definition. A. Training B. Personnel C. Human Factors Engineering D. Manpower E. Safety F. Occupational Health	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **D - Manpower** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **B - Personnel** --Types of faces	**B - Personnel** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **C - Human Factors Engineering** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **D - Manpower** --Types of faces	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **B - Personnel** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **D - Manpower** --Types of faces	**C - Human Factors Engineering** --Design for/around the human **E - Safety** --Prevent long term injuries and disabilities **B - Personnel** --Number of spaces or billets **A - Training** --Skill enhancement **F - Occupational Health** --Mishap and injury prevention **D - Manpower** --Types of faces
1.2 HSI is… A. Human Systems Interaction B. Human Factors Engineering C. Human Systems Integration D. Human Systems Interdependence	C - Human Systems Integration	C - Human Systems Interaction	C - Human Systems Integration	C - Human Systems Integration
1.3 HSI in the Air Force has _____ domains	D - Five (5)	B - Seven (7)	A - Nine (9)	A - Nine (9)

1.4 HSI identifies interdependencies and tradeoffs among…	B - HSI domains and Systems Engineering functions	C - HSI domains	C - HSI domains	D - Cost, schedule, and performance
1.5 HSI helps to ensure that the human is considered on par with the hardware and software during system design and development.	TRUE	TRUE	TRUE	TRUE
1.6 Performing HSI activities supports increased human performance	FALSE	TRUE	TRUE	TRUE
1.7 Effective consideration of HSI helps to reduce total ownership costs and safety mishaps.	TRUE	TRUE	TRUE	TRUE
Post-Test				

1.1 Match the following terms with the appropriate definition. A. Training B. Personnel C. Human Factors Engineering D. Manpower E. Safety F. Occupational Health	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **D - Manpower** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **B - Personnel** --Types of faces	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **D - Manpower** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **B - Personnel** --Types of faces	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **B - Personnel** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **D - Manpower** --Types of faces	**C - Human Factors Engineering** --Design for/around the human **F - Occupational Health** --Prevent long term injuries and disabilities **D - Manpower** --Number of spaces or billets **A - Training** --Skill enhancement **E - Safety** --Mishap and injury prevention **B - Personnel** --Types of faces
1.2 HSI is… A. Human Systems Interaction B. Human Factors Engineering C. Human Systems Integration D. Human Systems Interdependence	C - Human Systems Integration	C - Human Systems Integration	C - Human Systems Integration	C - Human Systems Integration
1.3 HSI in the Air Force has _____ domains	A - Nine (9)	A - Nine (9)	A - Nine (9)	A - Nine (9)
1.4 HSI identifies interdependencies and tradeoffs among…	A - HSI factors and cost	B - HSI domains and Systems Engineering functions	B - HSI domains and Systems Engineering functions	D - Cost, schedule, and performance

1.5 HSI helps to ensure that the human is considered on par with the hardware and software during system design and development.	TRUE	TRUE	TRUE	TRUE
1.6 Performing HSI activities supports increased human performance	FALSE	TRUE	TRUE	TRUE
1.7 Effective consideration of HSI helps to reduce total ownership costs and safety mishaps.	TRUE	TRUE	TRUE	TRUE